TTK4130 - Exercise 5

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Problem 1

a

For a Spool (like spool 2) where T, F and ω is in the same direction.

$$\sum \tau = J\alpha = J\dot{\omega} = T + F_i r + B_i \omega$$

The sign can be changed to accomodate for differant directions.

c

If we call the contraction of the spring x such that $v_2 - v_1 = \dot{x}$. Since everything in this system is massless the force equilibrium will be:

$$F_2 - F_1 = Kx^2 + B\dot{x}$$

Or equivalently

$$\dot{x} = \frac{-Kx^2}{B} + \frac{F_2 - F_1}{B}$$

d

Force balance in horizontal direction:

$$F_1 \sin\theta - F_2 \sin\theta = 0$$

Which means:

$$F_1 = F_2 = F$$

Vertical direction:

$$F_1 \cos\theta + F_2 \cos\theta = F_k$$

which means:

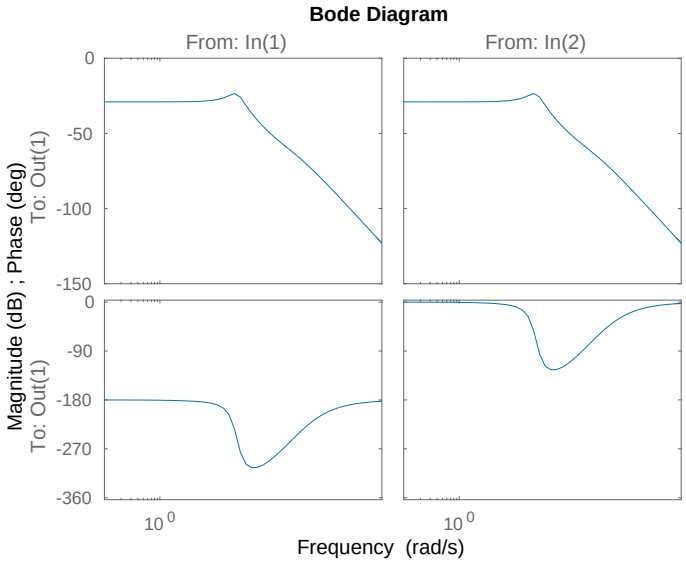
$$F_k = 2F\cos\theta$$

inserting into power balance gives:

$$\dot{x_k} = \frac{1}{2\cos\theta}(v_1 - v_2)$$

g

The bode looks like shown in Figure 1



Figur 1: Bode plot of drive/pulley system